BULLETIN

OF THE INSTITUTE OF METALS

VOLUME 5 JANUARY 1960 PART 5

INSTITUTE NEWS

Spring Meeting, London, 29–31 March

As previously announced, the 1960 Spring Meeting will be held in London from Tuesday, 29 to Thursday, 31 March, inclusive. The Council hopes it will be largely attended by members and guests. In particular it is hoped that members will give their support to the Annual Dinner, at which the Prime Minister and the American Ambassador will speak.

All members resident in Europe will receive a programme giving details of times, &c., and a Reply Form for completion in connection with this meeting. Others, resident outside Europe, who intend to be present are asked to apply for a Reply Form.

PROVISIONAL PROGRAMME

Tuesday, 29 March

Morning

Location: Church House, Great Smith Street, S.W.1.

Annual General Meeting:

Announcement of election of officers.
Report of Council for the Year ended 31 December 1959.
Report of the Honorary Treasurer for the Financial Year ended 31 August 1959.
Installation of the new President, Sir Ronald PRAIN, O.B.E., Hon.M.I.M.M.
Presidential Address of Sir Ronald PRAIN.
Presentation of Institute Medals:

The Institute of Metals (Platinum) Medal.
The Rosenhain Medal.
The W. H. A. Robertson Medal and Premium.

Afternoon

Scientific Session:

Discussion (separately) of two papers published in the *Journal:*

(1) "Precipitation Effects in Liquid Aluminium Alloys: Experiments with a Pulsed Electronic Technique", by N. D. G. Mountford and R. Calvert (Serial No. 1953; Nov., 1959).
(2) "The Embrittlement of Aluminium–Magnesium Alloys by Sodium", by C. E. Ransley and D. E. J. Talbot (Serial No. 1958; Dec., 1959).

Evening

Location: To be announced.

May Lecture:

"The Magnetism of Rocks and Continental Drift", by Professor P. M. S. BLACKETT, M.A., Hon.D.Sc., Hon.LL.D., F.R.S. (Visitors will be welcome; tickets are not required.)

Wednesday, 30 March

Morning

Location: Church House, Great Smith Street, S.W.1.

Scientific Session:

Discussion on the following paper, published in the *Journal:*
"Volume Increases in Fissile Materials on Neutron Irradiation and the Effects of Thermal Fluctuations", by G. W. Greenwood (Serial No. 1939; Sept., 1959).

Afternoon

PROGRAMME "A"

Location: Church House, Great Smith Street, S.W.1.

Scientific Session:

"New Aspects of the Electron Theory of Metals". An educational session arranged by the Metal Physics Committee. Short lectures will be given by Dr. J. FRIEDEL, Dr. V. HEINE, and Dr. W. M. LOMER, which will be followed by questions.

PROGRAMME "B"

Visit to Greenwich (Royal Naval College—including the Painted Hall—and the Queen's House). Ladies and other guests will be welcome.

Evening

Location: 17 Belgrave Square, S.W.1.

Conversazione and Exhibition, 7.30–10.30 p.m. Informal dress; tickets, price 10*s.*, including light refreshments. There will be a bar at which alcoholic and non-alcoholic drinks may be purchased. Ladies and other guests will be welcome.

Thursday, 31 March

Morning

PROGRAMME "A"

Location: Church House, Great Smith Street, S.W.1.

Technical Session:

"Rolling Hard Materials to Thin Gauges". A discussion, arranged by the Metallurgical Engineering Committee, based on the following papers published, or to be published, in the *Journal:*

(1) "Rolling Hard Materials to Thin Gauges: Basic Considerations", by H. Ford and J. M. Alexander (Serial No. 1966; Jan., 1960).

(2) "The Rolling of Thin Titanium Strip", by R. J. Wilcox and P. W. Whitton (Serial No. 1967; Jan., 1960).

(3) "Rolling Aluminium Foil: An Experimental Study on a Modern Mill", by Y. Yokote and S. Nomura (Serial No. 1977; Feb., 1960).

(4) "Some Experiences in Cold Rolling Thin Alloy Strip", by H. H. Scholefield, J. E. Riley, E. C. Larkman, and D. W. Collins (to be published in Mar., 1960).

PROGRAMME "B"

Scientific Session:

"Vacancies, Ageing, and Precipitation". A discussion based on the following papers published, or to be published, in the *Journal:*

(1) "The Effect of Specimen Size on the Quench-Ageing of an Aluminium–3·8% Copper Alloy", by V. Prakash and K. M. Entwistle (Serial No. 1909; Apr., 1959).

(2) "Quench-Ageing in Annealed Lead", by E. J. Hooker (Serial No. 1941; Sept., 1959).

(3) "Clustered Vacancy Defects in Some Face-Centred Cubic Metals and Alloys", by R. E. Smallman, K. H. Westmacott, and J. H. Coiley (Serial No. 1954; Nov., 1959).

(4) "Hardness Changes in Cold-Worked Aluminium Alloys During Slow Ageing Treatments", by N. Gane and R. N. Parkins (Serial No. 1962; Dec., 1959).

(5) "The Effect of Structural Imperfections on the Age-Hardening of Aluminium–Zinc Alloys", by R. D. Garwood and A. L. Davies (to be published in Mar., 1960).

Afternoon

Technical Session:

(1) Continuation of discussion on "Rolling Hard Materials to Thin Gauges".

(2) Discussion of the following paper to be published in the *Journal:*

"Resistance to Deformation of Aluminium and Some Aluminium Alloys: Its Dependence on Temperature and Rate of Deformation", by R. R. Arnold and R. J. Parker (Serial No. 1978; Feb., 1960).

Evening

Annual Dinner in the Great Room, Grosvenor House, Park Lane, W.1, at which the Prime Minister (The Right Hon. Harold MACMILLAN, P.C., M.P.) will be the principal guest and will propose the toast of "The Institute of Metals and the Non-Ferrous Metal Industries", and the United States Ambassador (His Excellency John Hay WHITNEY) will respond to the toast of "The Guests". Tables for 8, 10, or 12 may now be booked, and tickets may be reserved, of course, for individual members or smaller parties. Tickets, price 45*s.*, including coffee and service. (Evening dress, with decorations.) There will be dancing until 1 a.m., after the conclusion of the dinner.

"Metallurgical Reviews"

The latest issue (Vol. 4, No. 15) contains the following reviews: "The Hot Extrusion of Non-Ferrous Metals", by Richard Chadwick, and "The Theory of Semiconductors", by R. J. Elliott and P. C. Banbury.

Metallurgical Reviews, published quarterly by the Institute, is available only by annual subscription. The rates are: members 32*s.* 6*d.* ($5.00), post free, and non-members 50*s.* ($7.50) post free.

Election of Members

The following 1 Overseas Sustaining Member, 35 Ordinary Members, 5 Junior Members, and 29 Student Members were elected on 31 December 1959:

As Overseas Sustaining Member

MOTOR INDUSTRIES COMPANY, LTD., 22 Bannargatta Road, Adugodi, Bangalore, India.

As Ordinary Members

BALDOCK-WEBB, Frank Lewis, A.M.I.Mech.E., Engineer (Chief) of Metallurgical Division, Apex Construction Co., Ltd., Dartford.

BARNES, Thomas William, A.S.T.C., A.I.M., Lecturer in Metallurgy, University of New South Wales, Wollongong Division, N.S.W., Australia.

BERNSTEIN, Leonard, B.S., Hughes Semiconductors, Newport Beach, Calif., U.S.A.

BONISZEWSKI, Tadeusz, Mgr.inz., Asystent, Kadedra Metalografi, Akademia Górniczo, Krakow, Poland (temporarily at University of Cambridge).

CORNELIUS, Charles Taylor, M.E., Director and General Works Manager, Northern Aluminium Co., Ltd., London.

COX, Frederick Glynn, B.Sc., A.R.C.S., D.I.C., Ph.D., Principal Research Metallurgist, Murex, Ltd., Rainham.

DUNN, Cecil Gordon, Ph.D., Research Laboratory, General Electric Co., Schenectady, N.Y., U.S.A.

EATON, William Harvey, A.I.M., Chief Metallurgist, Associated Motor Cycles, Ltd., London.

HARRIS, Leslie Beran, B.A., B.Sc., Senior Scientific Officer, British Iron and Steel Research Association, London.

JENKINS, Graham James, A.I.M., Works Manager, The British Tin Smelting Co., Ltd., Liverpool.

JIROTKA (*Mrs.*), Zdenka Emilie, Actid, Ltd., Blantyre, Scotland.

JONES, Frederick Wilson, Ph.D., D.Sc., A.Inst.P., Manager, Brown-Firth Research Laboratories, Sheffield.

KALLMANN, Silve, M.S., Technical Director, Ledoux and Co., Teaneck, N.J., U.S.A.

KITSON, Anthony Ross Douglas, Personal Assistant to Sales Manager, Thomas Bolton and Sons, Ltd., London.

KOBRIN, Clarence Lewis, M.S., Metallurgical Editor, *The Iron Age*, Philadelphia, Pa., U.S.A.

KOMATSUBARA, Takejiro, D.Eng., Director, Central Laboratory, The Furukawa Electric Co., Ltd., Tokyo, Japan.

LAMBIE, John, L.I.M., Metallurgist, Carron Co., Falkirk.

LANGFORD, Haydn Maurice Antony, Assistant Metallurgist, Metal and Plastic Components, Ltd., Birmingham.

MCFARLANE, James Sinclair, M.A., Ph.D., A.I.M. Assistant Chief Metallurgist, Henry Wiggin and Co., Ltd., Hereford.

MARRIOTT, David John Digby, Liaison Officer, British Iron and Steel Research Association, London.

MARSHALL, Alec Frank, B.Eng., Head, Engineering Division, The B.S.A. Group Research Centre, Birmingham.

MAUNDURY, André, Ing., Ingénieur-métallurgiste, Comptoir Lyon Alemand, Louyot et Cie, Paris, France.

MUETZEL, Peter Siegfried, Technical Director, Perdeck Solder Products, Ltd., Waltham Abbey.

OSINA, Vladislav, Doc.Ing., Lecturer, Vysoké Učení Technicke v Brné, Úroz 33, Brno, Czechoslovakia.

PITCHER, David Edward, L.I.M., Metallurgist, Research Laboratories, The British Aluminium Co., Ltd., Gerrards Cross.

PLUMBE, Wilfrid John, F.L.A., Librarian, University of Malaya in Kuala Lumpur, Pantai Valley, Kuala Lumpur, Malaya.

ROLDÁN, *Professor* David, Mechanical and Electrical Engineer, Cobre y Aleaciones S.A., Mexico 14, D.F., and Professor of Industrial Organization in the Instituto Politécnico Nacional, Mexico City.

SARGINSON, Neil Merrick, B.Sc. (Tech.), A.M.C.T. The British Aluminium Co., Ltd., Warrington.

SEIDEL, Jurg Robert Heinrich, Dipl.Ing. Research Metallurgist, Fonderie Boillat S.A., Reconvillier, Switzerland.

SHELTON, George, Managing Director, Serck Tubes, Ltd., Birmingham.

SMITH, Frederick Charles, Technical Director, Sintering and Brazing Furnaces, Ltd., Slough.

STORCHHEIM, Samuel, M.S., President, Storchheim Research and Development Corp., Woodside, N.Y., U.S.A.

SUMSION, Henry Theodore, M.S., Ph.D., Research Metallurgist, Lockheed Aircraft Corp., Missiles and Space Division, Palo Alto, Calif., U.S.A.

THOMAS, Harold David, A.I.M. Lecturer, Technical College, Neath, Glam.

YAMANE, Toshimi, Dr.Eng., Research Engineer, Technical Research Laboratory, Hitachi Shipbuilding and Engineering Co., Ltd., Osaka, Japan.

As Junior Members

BECKWITH, David John, B.Sc., Research Metallurgist, Research Laboratories, The General Electric Co., Ltd., Wembley.

BREESE, Paul, A.M.C.S.T., Assistant Manager (Steel Plant), Lancashire Steel Manufacturing Co., Ltd., Irlam.

GOODWYN, John Barry, Lecturer in Metallurgy, Southall Technical College, Southall.

NEALE, Raymond William George, L.I.M., Metallurgist, British Non-Ferrous Metals Research Association, London.

WOODHOUSE, John Barry, B.A., Project Manager, Metals Research, Ltd., Cambridge.

As Student Members

ABBOTT, Frank Douglas, Research Assistant I, British Iron and Steel Research Association, London.

ARMITAGE, Charles Harold, M.S., Post-Graduate Student, Department of Mining and Metallurgy, University of Wisconsin, Madison, Wis., U.S.A.

ARNELL, John David, Laboratory Assistant, The Mond Nickel Co., Ltd., London.

BJELETICH, John George, Student, Montana School of Mines and Metallurgy, Butte, Mont., U.S.A.

BOWDEN, Piers Brim, B.A., Research Student, Department of Metallurgy, University of Cambridge.

BROWN, John William Greenhough, Undergraduate, Department of Metallurgy, University of Cambridge.

CAVE, Donald Henry, Undergraduate, Department of Metallurgy, University of Cambridge.

DANIEL, William Whitmore, L.I.M., Assistant Research Metallurgist, Bradley and Foster, Ltd., Darlaston.

DURDALLER, Cornelius Gerard, M.S., General Electric Fellow in Metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa., U.S.A.

GILES, Maurice Eric, L.I.M., Student, Metallurgy Department, Battersea College of Technology, London.

GREGSON, David, Student, Department of Metallurgy, Battersea College of Technology, London.

HARRISON, Roger Philip, Undergraduate, Department of Metallurgy, University of Manchester.

HASSALL, James Oliver, Undergraduate, Department of Metallurgy, University of Cambridge.

HENDRICKS, Robert Wayne, B.Met.E., Graduate Student, School of Metallurgical Engineering, Cornell University, Ithaca, N.Y., U.S.A.

HUNT, John David, Undergraduate, Department of Metallurgy, University of Cambridge.

LATHAM, David John, B.Sc., Research Student, Department of Industrial Metallurgy, University of Birmingham.

MAYER, George, B.S., Graduate Student, Department of Metallurgical Engineering, University of Oklahoma, Norman, Okla., U.S.A.

MUKHERJEE, Amiya Kumar, B.Sc., M.Met., Postgraduate Research Scholar, Department of Metallurgy, University of Oxford.

MURRAY, Gordon Arthur William, Undergraduate, Department of Metallurgy, University of Cambridge.

NADIN, Geoffrey, Student, Manchester College of Science and Technology, Manchester.

NEATE, Donald Albert, Student, Manchester College of Science and Technology, Manchester.

NEWMAN, David Robert, Junior Metallurgist, Metallurgical Research Laboratory, Fairey Aviation, Ltd., Hayes.

ROBERTS, John William, Trainee Metallurgist, Richard Thomas and Baldwins, Ltd., Scunthorpe.

SUNDQUIST, Bruce Edmund, B.S., Graduate Student, Department of Metallurgical Engineering, Illinois Institute of Technology, Chicago, Ill., U.S.A.

TILLEY, Roy Munro, Assistant Metallurgist, Development and Research Department, Platinum Metals Division, The Mond Nickel Co., Ltd., London.

WARDLAW, John Arthur, Metallurgical Laboratory Assistant, Wilkinson Sword, Ltd., Slough.

WESTERN, Robert Geoffrey, Undergraduate, Department of Metallurgy, University of Manchester.

WINTERS, Leslie William, Metallurgist, Enfield Rolling Mills, Ltd., Brimsdown.

WOYKA, Alexander Stuart, Undergraduate, Department of Metallurgy, University of Cambridge.

PERSONAL NOTES

Mr. B. J. Alperin has been appointed Manager of Product Engineering at the Everett Foundries of the General Electric Co., Everett, Mass.

Mr. I. S. Brammar has left Sheffield University and taken up a post as a research metallurgist at the Tube Investments Research Laboratories, Hinxton Hall.

Dr. D. W. Davison has been transferred to the Central Personnel Executive staff at the Head Office of The Plessey Co., Ltd., Ilford, to assist the Personnel Director with scientific and technical appointments throughout the Company and its Associates.

Dr. R. T. Fowler has been awarded the degree of D.Sc. in Engineering by the University of Sydney and has been appointed Professor of Chemical Engineering in the University of New South Wales.

Mr. H. S. Gupta has joined the Indian Smelting and Refining Co., Ltd., Bombay, as chief works metallurgist.

Mr. A. G. Harding has left the Metallurgy Division of the Atomic Energy Research Establishment and is now a lecturer in the Department of Engineering at the College of Technology, Bristol.

Mr. E. S. Hart has retired from his position with The British Aluminium Co., Ltd., Falkirk.

Mr. R. A. Hetherton has left Fisons, Ltd., and has taken up a position with The Metal Box Co., Ltd., Research Division, Acton.

Dr. W. G. Hiscock has been appointed Chairman of the Lead Development Association for 1960.

Dr. J. C. Hudson, Head of the Corrosion Section of the British Iron and Steel Research Association, is the recipient of the Frank Newman Speller Award for 1959. The award is made by the (American) National Association of Corrosion Engineers.

Dr. P. H. Jennings has left the County Technical College, Wednesbury, and taken up a position in the Research and Development Department of Canadian Copper Refiners, Ltd., Montreal East, P.Q.

Mr. K. S. Krishnan has left India and is now engaged in graduate studies in the School of Metallurgical Engineering, Purdue University, Lafayette, Ind.

Professor R. F. Mehl, on leave of absence from the Carnegie Institute of Technology, is now in Europe to open an office in Zürich as consultant to the United States Steel Corporation.

Mr. J. S. Morton has been appointed to the board of EFCO, Ltd.

Professor Dr. W. Oelsen has been appointed Director of the Max-Planck-Institut für Eisenforschung, Düsseldorf.

Mr. S. C. Pearce, Technical Manager of H. J. Enthoven and Sons, Ltd., has been awarded the Ph.D. degree of the University of London.

Mr. R. J. Phillips has left Cambridge University and is now a technician in the Metallurgical Department of Stewarts and Lloyds, Ltd., Corby.

Mr. F. T. Sisco has resigned his position as Director of the Engineering Foundation, New York. He remains Director of the Alloys of Iron Research of the Engineering Foundation.

Dr. R. L. Smith, Technical Director of the Research Laboratories of the Franklin Institute, has been appointed Head of the Department of Metallurgical Engineering at the Michigan College of Mining and Technology, Houghton, Mich.

Mr. D. E. Thomas has been appointed Manager of Metallurgy in the newly formed Astronuclear Laboratory of the Westinghouse Atomic Power Division, Pittsburgh, Pa. He was formerly Manager of Naval Reactor Metallurgy at the Westinghouse Bettis Laboratory.

Dr. J. Weertman has relinquished his position as Scientific Liaison Officer at the U.S. Office of Naval Research in London, and is now Associate Professor of Metallurgy at Northwestern University, Evanston, Ill.

Mr. J. C. Wright has been appointed Reader in Industrial Metallurgy at the College of Advanced Technology, Birmingham. He was previously Senior Lecturer.

Deaths

The Editor regrets to announce the deaths of:

Mr. Paul Alexander, Director of Research, Continental Can Co., Inc., Roosevelt, N.J., U.S.A.

Richard Arthur Owen-Barnett, of the Research Department, Whitehead Iron and Steel Co., Ltd., Newport, Mon., on 3 December 1959.

OBITUARY

Mr. C. E. Prosser

The death occurred recently at his home in Birmingham of Mr. Cyril Ernest Prosser, a former Chairman of the Metals Division of Imperial Chemical Industries, Ltd. He was 66.

Born at Abertillery, Mr. Prosser came to Birmingham as a youth and joined Elliott's Metal Co., later becoming its sales manager. When that firm and British Copper Manufacturers, Ltd., were merged with Kynochs Ltd. under I.C.I., he was appointed assistant sales manager of the combined metals departments.

Appointed a delegate director in 1936, he later served as Joint Managing Director and finally as Chairman of the Metals Division. When he retired in 1955 he had completed 45 years' service with the group.

Throughout his career Mr. Prosser played a leading part in the counsels of the non-ferrous metals industry, having been Chairman of the Brass Wire Association, the Brass and Copper Tube Association, the Condenser Plate Association, and the Manufactured Copper Association.

During the First World War he served in the South Wales Borderers and was commissioned in the Machine Gun Corps; in the Second World War he was Chairman of the Government-appointed panel that co-ordinated supplies of non-ferrous tubes and shell bands.

Mr. Prosser had been a member of the Institute since 1925.

LECTURES TO THE INSTITUTE, LOCAL SECTIONS, AND ASSOCIATED SOCIETIES

Beryllium Metal—Its Production, Properties, and Applications

A Joint Meeting between the Institute of Metals and the Bristol and District Sections of the Chemical Society, Royal Institute of Chemistry, and the Society of Chemical Industry was held in the Chemical Department Lecture Theatre of the University of Bristol on the evening of Thursday, 3 December. Mr. E. W. Greensmith, Chairman of the Chemical Engineering Group of the Society of Chemical Industry, took the Chair.

Dr. G. A. Wolstenholme, of the National Smelting Co., Ltd., Avonmouth, delivered a most interesting lecture on "Beryllium Metal: its Production, Properties, and Applications", after which there was a discussion. A vote of thanks to the lecturer was proposed by Mr. E. R. Gadd, Member of the Institute of Metals.

There was a larger attendance than usual at this annual joint meeting between the Societies, and a good attendance afterwards at an informal dinner in the Senior Common Room.

The lecturer traced the history of beryllium production from the discovery of the element by Vauquelin in 1798 and its isolation for the first time in 1828 by Wöhler in Germany and Bussy in France. He said that, until recently, the beryllium industry had grown almost entirely around beryllium copper alloys, following the discovery in the early 1930's that beryllium would age-harden copper. Very little attention had been paid to beryllium metal itself until uses were found for it in nuclear reactors, and commercial production did not really start until after the Second World War.

It was explained that current interest in beryllium metal stemmed mainly from its use as a moderator or reflector in nuclear reactors, and as a possible canning material for uranium oxide fuel in the advanced gas-cooled reactor now being developed by the United Kingdom Atomic Energy Authority. Beryllium metal also had possible applications as a light-weight structural material for high-speed aircraft and rockets on account of its high strength : weight ratio (the density of beryllium = 1·85 g/c.c.), relatively high melting point (1283° C), high elastic modulus (40,000,000 lb/in^2), and excellent thermal conductivity. Lack of three-dimensional ductility had retarded development for this purpose, but, despite this drawback, parts of rocket guidance systems were now being made of beryllium in the U.S.A. The metal was also considered to be one of the more promising materials for rocket nose cones, and might provide a solution to the problem of re-entry into the Earth's atmosphere.

Beryllium was produced commercially by two methods—electrolysis of the chloride or thermal reduction of the fluoride with magnesium. The lecturer described the thermal-reduction method in detail, laying emphasis on the special materials of construction, e.g. graphite, beryllia, plastics, &c., which were used in furnaces and other equipment to avoid impurity pick-up. He then discussed the underlying reasons for lack of ductility in ingot beryllium, and went on to describe how powder-metallurgical techniques of fabrication had given improved properties.

The lecturer said that the present high cost of beryllium could be expected to fall in future as new uses for the metal developed and production increased. The known reserves of beryl ore were adequate for a world output of a few hundred tons per annum if the demand arose. On the other hand, beryllium was difficult to produce and would always be expensive compared with metals such as aluminium and magnesium which were produced in very large tonnages.

In conclusion, Dr. Wolstenholme referred to the toxic nature of beryllium-containing fumes and dust, which had caused illness among workers in the early years of the industry. This problem had now been overcome by adequate ventilation of equipment and strict hygiene precautions. Although lack of ductility remained a problem, beryllium metal was usable in its present forms for many purposes, and there was little doubt that its use as a material of construction would become established.

The Theory of Rolling

Professor Hugh Ford, of Imperial College, London, gave a lecture on the theory of rolling to the Oxford Local Section at its meeting on 3 November 1959.

The purpose of rolling theory is to relate the mechanical properties of the strip to the roll force, tensions and torque, in terms of the pass geometry, through an analysis of the stresses and deformations in the roll gap.

The theory for cold rolling has reached an advanced stage because the assumptions von Kármán used in 1925 are in good accord with experimental evidence. The main assumptions are that: (1) the arc of contact is circular, (2) the coefficient of friction is constant over the arc of contact, (3) there is no lateral spread (plane strain), and (4) plane sections perpendicular to the direction of rolling remain plane during the pass. This implies slipping friction throughout.

The main developments since von Kármán's work have been in a more realistic interpretation of yield and work-hardening and of the coefficient of friction. In cold rolling, roll distortion is important in that the arc of contact is longer than for an undistorted roll. Assuming that the roll pressure distribution is roughly elliptical, the roll surface can be shown to remain circular but of greater radius. Hitchcock used this result in his formula relating the flattened radius to the roll force and pass reduction.

The strip tensions reduce the roll force and modify the roll torque; they can be incorporated in von Kármán's differential equation as boundary conditions.

Approximations have to be made to von Kármán's equation to allow of integration to give the roll pressure at any point in terms of the yield stress. Thereafter, the total roll force and torque can be calculated numerically if the variation of the yield stress is allowed for, or by a second integration if a mean yield stress is used.

For the smaller passes on harder materials, the elastic arc of contact at exit, caused by the elastic recovery of the strip, has to be incorporated. This may augment the roll force up to 10%.

The time-consuming aspect of the problem is to achieve consistency between the equation for the plastic deformation of the strip and the equation for the elastic flattening of the roll. The solution can be found by successive approximation or by nomographs.

Making all the refinements and feeding-in the yield-stress data and coefficient of friction measured by the best techniques,

the theory predicts roll force and torque to about $\pm 5\%$ over the normal range of cold-rolling practice.

Hot-rolling theory has made progress lately. Sims has made the same assumptions as von Kármán except that the friction is assumed to be so high that the strip " sticks " to the roll throughout and the yield stress depends upon the rate of deformation. On the other hand, reliable experiments to check the theory are more difficult to perform. Alexander has proposed an " exact " solution from the mathematical theory of plasticity that shows promise, but much still remains to be done.

Bearing Metals

Members of the Manchester Metallurgical Society, at their meeting on 11 November 1959, heard a lecture on bearing metals delivered by Mr. P. G. Forrester, of the Glacier Metal Co., Ltd.

The performance of a lubricated plain bearing depends on a considerable number of factors besides the material of which the bearing is made. Thus, in spite of much recent research on the nature of solid friction and wear, and of numerous forms of laboratory test, the development of materials still depends very largely on field experience and testing. Field wear tests, combined with fatigue tests on rigs, now rate the available engine bearing materials as follows. Tin- and lead-base white metals minimize shaft wear due to abrasive particles in the lubricant, but have a relatively low fatigue resistance. Copper–lead alloys give almost twice the fatigue strength at the cost of approximately twice the rate of shaft wear and the risk of corrosion by oxidized oils. Lead–tin or lead–indium electroplated overlays reduce shaft wear and avoid corrosion, but may wear off after prolonged service and expose the copper–lead base. Aluminium alloys containing about 20% tin can now be bonded to steel; these give a fatigue strength greater than copper–lead alloy, combined with a lower rate of shaft wear (about 50% more than white metal), and excellent corrosion resistance.

The great majority of bearings and small bushes are now made from bimetal strip, i.e. steel lined with white metal, copper–lead alloy, lead–bronze, or aluminium–tin alloy. White metal is bonded to steel by continuous casting, copper–lead alloy and lead–bronze by sintering or casting, while aluminium–tin alloy is bonded by rolling. In all these processes, structure, strength and bond can be controlled by statistical quality-control methods, thus ensuring a high quality of product. Bimetal strip so produced is made into bearings by pressing and machining. Bearings whose shape prevents manufacture from strip are made by specialized casting operations. The displacement method of lining a steel shell with copper–lead alloy is of particular interest; in this, the core is placed in position after casting the metal, thereby displacing some of the copper–lead alloy.

Bearings utilizing porous bronze impregnated with polytetrafluoroethylene, which are now in widespread use, operate entirely without lubrication under load/speed conditions of up to about 20,000 ($lb/in^2 \times ft/min$). This material is made by sintering spherical bronze powder on to copper-plated steel, and subsequently impregnating with a P.T.F.E.-based mixture.

The more conventional oil-impregnated porous bronze bearings, also made by powder metallurgy, have large numbers of applications. It has recently been shown that in these bearings, the normal pattern of hydrodynamic behaviour is modified by pressure-leakage due to the porosity of the material.

Metallurgical Research in the U.S.S.R.

At a meeting of the Manchester Metallurgical Society held on 28 October 1959, Dr. K. J. Irvine, of the Research Laboratories of The United Steel Companies, Ltd., described a visit he made to Russia in October 1958. This visit was sponsored by the British Iron and Steel Research Association, and one of its main objectives was to attempt to form a link between B.I.S.R.A. and the Central Research Institute for Ferrous Metallurgy in Moscow. Visits were made to this Central Research Institute, the Baikov Institute of Metallurgy in the Academy of Sciences, Moscow University, and the Stalin Institute of Steel, the Central Laboratory of Automation, the State Institute for the Design of Metallurgical Works, and the Institute of Electronic Machines. As a result of the visit it was possible to arrange for future exchanges of specialist teams, and one subsequent visit (to study continuous casting) has already been made.

The Central Research Institute has a total staff of 2500 and includes an experimental factory with all the processing equipment necessary to produce new steels in sheet, bar, or tube form. It also has control over a small steelworks at Nova Tula, near Moscow, where research on blast furnaces and continuous casting is carried out. All the laboratories are extremely well equipped, and there is great emphasis on basic physical-metallurgy studies.

The Baikov Institute of Metallurgy is one of the departments in the division of technical science of the Academy of Sciences. It has a staff of 850 and concentrates on the more fundamental work. However, it has close links with the Central Research Institute, particularly as Academician I. P. Bardin is Director of both establishments.

The general impression gained from this visit was that a very large effort is being devoted to metallurgical research in Russia. The availability of English translations of Russian scientific periodicals now makes it easier to see the results of this work. It is to be hoped that future exchanges will bring metallurgists of the two countries into closer contact.

OTHER NEWS

Golden Jubilee of " The Metal Industry "

The Metal Industry, on 4 December 1959, celebrated its Golden Jubilee with a specially enlarged issue. This contained a number of messages of congratulation, including one from Lord Hailsham, as Minister of Science, and one from the President of the Institute of Metals (Mr. G. L. Bailey). The rest of the issue was devoted mainly to a series of review articles outlining developments in the use of non-ferrous materials in various industries during the last 50 years.

Corrosion Science Society

The formation is announced of the Corrosion Science Society with the following immediate aims:

(1) To promote the advance of corrosion science and its application to the solution of practical problems.

(2) To organize meetings—personal, local, national, and international—of scientifically qualified persons interested in all fields of corrosion and corrosion-protection research and practice, for the discussion of current work.

(3) To co-operate with all other professional individuals, societies, and institutes, British and foreign, with interests in the corrosion field.

The first meeting will be held on 4–5 April 1960, at Battersea College of Technology, London. Stress-corrosion cracking, the corrosion and protection of aluminium, cathodic

Price List of Publications

Note.—Prices quoted in dollars, for the convenience of American and Canadian purchasers, include an allowance for charges for collection of cheques. Customers' cheques on their American or Canadian banks will be accepted.

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Research Scholarship

A research scholarship in the use of light alloys in structural engineering is offered every third year by the Institution of Structural Engineers in collaboration with the Aluminium Development Association. The duration of the scholarship is two years and the value £600 per annum.

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Details and application forms are obtainable from the Secretary of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1. Completed application forms should be sent in to reach the Secretary by 31 March, 1960.

DIARY

The Institute

29–31 March. Spring Meeting, Church House, Great Smith Street, London, S.W.1.

31 March. Dinner and Dance at Grosvenor House, Park Lane, London, W.1, at 7.30 p.m. (Principal Guest: The Prime Minister, The Right Hon. Harold Macmillan, P.C., M.P.)

Local Sections and Associated Societies

1 March. Oxford Local Section. Junior Members' Evening. "Developments in Mechanical Testing Methods": (*a*) "Hot Hardness Testing", by O. P. Hartree; (*b*) "The Mechanical Testing of α-active Materials", by P. M. French; (*c*) "The Mechanical Testing of γ-active Materials", by J. E. Bainbridge. (Cadena Café, Cornmarket Street, Oxford, at 7.0 p.m.)

1 March. South Wales Local Section. Annual General Meeting, followed by "Porosity in Sintered Materials", by Professor R. Higgins. (Metallurgy Department, University College, Singleton Park, Swansea, at 6.30 p.m.)

3 March. Birmingham Local Section. "The Effects of Irradiation on Reactor Materials", by Dr. H. M. Finniston. (College of Technology, Gosta Green, Birmingham 4, at 6.30 p.m.)

3 March. Liverpool Metallurgical Society. "Semiconductors", by R. P. Chasmar. Official visit of the President of the Institute of Metals, with the Secretary. (Library of the Department of Metallurgy, The University, 146 Brownlow Hill, Liverpool 3, at 7.0 p.m.)

3 March. London Local Section. "Patent Law", by C. E. Every. (17 Belgrave Square, London, S.W.1, at 6.30 p.m.)

5 March. Liverpool Metallurgical Society. Seventh Annual Conversazione. (The University Club, Mount Pleasant, Liverpool, at 7.15 for 7.45.)

9 March. Manchester Metallurgical Society. "Metallurgical Aspects of Fuel Elements for Reactors", by Dr. H. M. Finniston. (Manchester Room of The Central Library, Manchester, at 6.30 p.m.)

10 March. East Midlands Metallurgical Society. "Oxygen in Steelmaking". (Metallurgy Department, University of Nottingham, at 7.30 p.m.)

10 March. Leeds Metallurgical Society. "Unpopular Methods for Establishing Equilibrium Diagrams", by Dr. H. W. Rayson. (University Staff House, University Road, Leeds, at 6.30 p.m.)

14 March. North East Metallurgical Society. "Developments in the Welding of Pressure Vessels", by Dr. H. Harris. (Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, at 7.30 p.m.)

15 March. South Wales Local Section. "Atomic Structure and the Properties of Metals", by Professor N. F. Mott. (Metallurgy Department, University College, Singleton Park, Swansea, at 6.30 p.m.)

16 March. Liverpool Metallurgical Society. Visit to Pilkington Brothers, Ltd., St. Helens.

17 March. Birmingham Local Section. Annual General Meeting and Chairman's Address. Official visit of the President of the Institute of Metals, with the Secretary. (College of Technology, Gosta Green, Birmingham 4, at 6.30 p.m.)

17 March. London Local Section. Third Annual Informal Dinner, to be held at the Horse Shoe Hotel, Tottenham Court Road, London, W.1.

21 March. Scottish Local Section. "Methods Used in the Jewellery and Silverware Industries", by Miss Dorothy Pile. (Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow, C.2, at 6.30 p.m.)

24 March. Sheffield Local Section. "Molybdenum", by Dr. L. Northcott. (Applied Science Building, the University, St. George's Square, Sheffield, at 7.30 p.m.)

31 March. Southampton Metallurgical Society. Annual General Meeting, followed by "Stress-Corrosion", by Dr. H. K. Farmery. (Engineering Block, Southampton University, at 7.15 p.m.)

APPOINTMENTS VACANT

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